Comment on "Spatial Coherence and Optical Beam Shifts"

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A recent letter by Löffler *et al.* [1] presents experimental results concluding that the degree of spatial coherence does not influence the spatial Goos-Hänchen (GH) shift. The authors measure the difference of the GH shift, $D_p - D_s$, for p- and s-polarization of partially coherent light, but the absolute GH shift, D_p or D_s, is not presented. However in our papers [2, 3], we show the absolute GH shift, D_p or D_s, is affected by spatial coherence. Their experimental result shows that the measured value, $D_p - D_s$, is independent of the ratio σ_g/σ_s, where σ_g and σ_s are the spatial coherence and the beam width, respectively. They then conclude that "this demonstrates that the theoretical result in Refs. [4–6] is correct, contrary to competing claims [2, 3]" and hence the "dispute in the literature [2–6] is now definitively resolved". We disagree.

This comment is to show that our simulation data, based on the theory and method in Ref. [2], are also in agreement with their experimental data presented for $D_p - D_s$ in [1]. Then we also demonstrate how to show the effect of spatial coherence on the GH shifts.

Before presenting our results, we point out that the incident partially coherent fields, Eq. (7) in Ref. [2], can be well approximated from Eq. (3) in Ref. [6] due to two facts: (a) the dimensionless quantities, $y_{1,2}(\sin\theta)/(k\alpha)$, are extremely small in laboratory coordinates, so that we have $\gamma_{1,2} = \alpha - y_{1,2}\sin\theta/(2k) = \alpha[1 - y_{1,2}\sin\theta/(2k\alpha)] \rightarrow \alpha$ for Eq. (4) in Ref. [6]; (b) the higher-order phase term, $\exp\left\{\frac{ik\cos^2\theta\sin\theta y_1 y_2(y_2-y_1)}{8k^2(\alpha^2-\beta^2)}\right\}$, can be replaced by unity in the presence of the term $\exp\{-ik\sin\theta(y_2 - y_1)\}$. Furthermore, Eq. (7) in Ref. [2] describes the field distribution at the interface, which can be assumed to be of any shape including Gaussian as well as a point-like source. Our method is exact and is valid in both paraxial and non-paraxial regimes (see Eq. (4) in Ref. [2]).

In Fig. 1, we compare our simulation data with their experimental results [1] and their prediction curve for the three cases: (a) $\sigma_g/\sigma_s \gg 1$ ($\sigma_s \approx 0.4$mm), (b) $\sigma_g/\sigma_s = 0.149$ ($\sigma_s \approx 0.9$mm), and (c) $\sigma_g/\sigma_s = 0.068$ ($\sigma_s \approx 2.1$mm). It is clear from Fig. 1, that our simulation results are nearly the same as their theoretical results, and both have only small difference from the experimental data. Therefore their experimental data should not form the basis of an objection to our claims in [2, 3].

A question of interest is: How can we obtain a substantial difference between our simulation and their predictions? We note that, in the experiments discussed above,

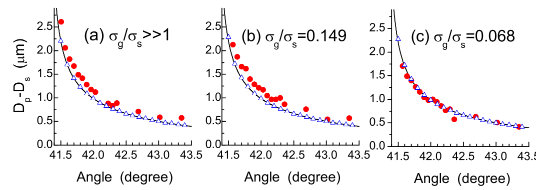

FIG. 1: (Color online) Comparision of our simulation data and their prediction with the experimental data [1]. Here solid dots are experimental data, open triangles are our simulation data, and solid curves are the predictions of Refs. [4–6].

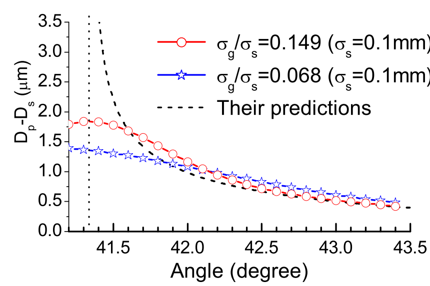

FIG. 2: (Color online) Effect of spatial coherence on $D_p - D_s$.

although σ_g/σ_s is considerably small, the absolute values, σ_g and σ_s, are much larger than the wavelength, λ. If σ_g is close to λ but is still larger than λ, and σ_g/σ_s is fixed, then D_p, D_s, and even $D_p - D_s$ in our simulation and their prediction will be significantly different especially near the critical angle as shown in Fig. 2. The degree of spatial coherence σ_g will then have a large effect on the GH shift. This is basically our claim based on the theory presented in Refs. [2, 3].

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